

The Association Between Swimming Pool Operator Certification and Reduced Pool Chemistry Violations — Nebraska, 2005–2006

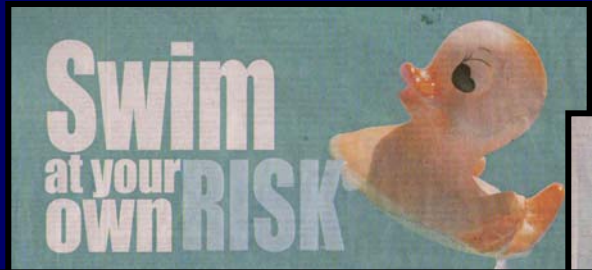
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Swimming in United States

- Most popular children's recreational activity
- Second most popular — all ages
- 360 million recreational-water venue visits per year
- Growing numbers of reported outbreaks of illness associated with recreational water exposure

Chlorine mixture may be problem



Boy treated after swimming in motel pool
 Pool closed after tests indicate chemical levels outside the normal range for safe swimming.
 State health officials Boy it back to non- Argutina said the chemical burns.

BY MARK ANDERSON
 The pool at the hotel you're staying at on your family vacation seems a bit sketchy. But the brats in the backseat have been pushing each other's buttocks since leaving Denver, and something needs to absorb that energy. But when the pool, dripping dandruff, returns to the room, they look like WMD test subjects: eyes red, coughing, throats swollen, and reeking of chloroform. Can this be something worse than pool chloroform? It is. It's chloramines, a gaseous chlorine byproduct created when weak chlorine levels in a body of water combine with human byproducts. Think sweat, urine and other waste. The potent irritant can make you sick. Last Christmas Day in Bellevue, the parents of a 6-year-old boy who'd visited a motel pool rubbed their child's forehead, short of breath, vomiting, with a coughing cough, reddened eyes and an irritated throat — to a hospital, where he spent the night in intensive care; he was OK the next day. Investigators later discovered four others who stayed at the motel sought medical care, and at least 24 people fell ill after breathing near the poorly maintained motel pool. BY WRITER, Page 5C

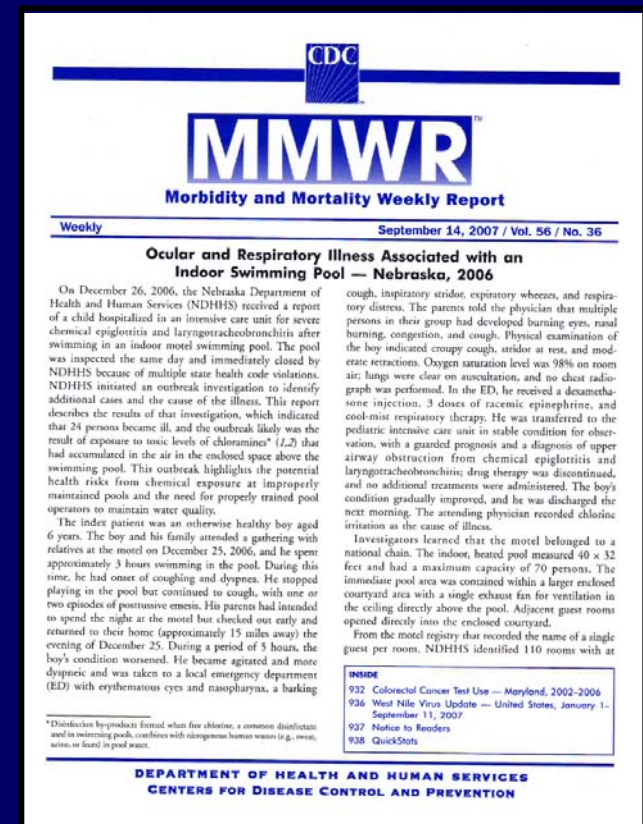
Chlorine | Woman said pool area smelled like bleach
 From AS
 men caused asthma attacks that her children have not had since last year. "We've all been on aerosol machines since Sunday night as well as antibiotics and steroids," Fletcher wrote on March 8. In spite of the hospital trip, Fletcher said her family enjoyed their stay at the park — notwithstanding a strong chlorine smell in the air. "It was as if I opened up a bottle of bleach and took a deep breath inside the bottle," Collins said chlorine in the air is a typical problem with indoor pools, especially crowded, heated pools. "We know for a fact when you're dealing with heated pools and a high activity level, there's going to be more chlorine going airborne — but the cause of the heat," he said. Investigators have contacted the Cent Wolf Lodge in Bernhardt, which uses the same ventilation system as the Mass lodge, but no problems have been reported there. Collins guessed problems in Mass could be due to a higher

That strong chlorine smell at the hotel pool may not be a good thing. Poorly maintained public pools pose a real health hazard. Here's what to watch for.

Officials said these health hazards may be combining with chlorine in the indoor pool to create chloramines — a compound that causes symptoms similar to those in complaints, health officials said. About 85 families have complained in the last several months of burning eyes, respiratory problems, coughing, and in some cases skin rashes, according to Dan Collins, director of environmental health for the county. Collins said that number is a small percentage of swimmers considering the pool area probes between 2,000-3,000 people on weekends, but it's enough to compel health officials to take action. Collins said his agency is endorsing the help of the National Institute for Occupational Safety and Health. That agency will test the pool area in the next few days. Jennifer Fletcher, who lives in Lenoir, said her family's nursing at Great Wolf resulted in a trip to the emergency room. She said conditions in the pool

Swimming Pool-Associated Illness — Nebraska, December 2006

- Preventable outbreak in indoor, motel swimming pool
- Inadequate management
 - Uncertified operator
 - No verifiable training
- Chloramine toxicity
 - Ocular and respiratory illness
 - 24 persons, child in PICU
- Pool inspected and closed
- Abnormal water chemistry



<http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5636a1.htm>

Acceptable Swimming Pool Chemistry

Nebraska Acceptable Range

Free chlorine

2–10 ppm

pH

7.2–7.8

Combined chlorine
(Chloramine)

≤0.5 ppm

Chemistry Violations — Outbreak-Associated Pool, Nebraska 2006

	Nebraska Acceptable Range	Dec. 26, 2006 Reported Value
Free chlorine	2–10 ppm	0.8 ppm
pH	7.2–7.8	3.95
Combined chlorine (Chloramine)	≤0.5 ppm	4.2 ppm

National Pool Inspection Data — CDC, 2003

- 22,131 inspections — May–September, 2002
 - 11,973 (54%) ≥ 1 violation
 - 8% immediate pool closure
- 21,561 total violations
 - 39% water-chemistry violations
- Pool type
 - 18% child wading
 - 14% medical/therapy
 - 14% hotel/motel



Photo sources: pomperaughealthdistrict.org (top); www.clark.wa.gov (bottom)

Public Pool Operator Training

- 20 states require verifiable training for public pool operators (2006)
- Nationwide, operators responsible for proper maintenance and operation of public pools — minimal public health oversight
- In Nebraska, only 1 annual inspection per pool required



Photo source: CDC Public Health Image Library

Objective

- Evaluate association between pool operator certification and chemistry violations in Nebraska pools

Methods

Data Source

- **Nebraska 2005–2006 statewide pool-inspection reports**
- **Routine inspection reports with values for both free chlorine and pH**
- **Start-up, follow-up, and complaint inspections excluded**

Nebraska Public Swimming Pool Classes and Regulations

- **Class A**
 - Municipal pools
 - Trained, certified operators required onsite at all times when open
- **Class B**
 - Motel, hotel, apartment complexes, others
 - Douglas County (Omaha metro area) and City of Lincoln require trained/certified operators
 - Certification not required in all other Nebraska counties (n=91)

Analysis of Free Chlorine Violations

- **Compared free chlorine violations (<2 ppm or >10 ppm) in Class B versus Class A pools**
 - **Counties without Class B operator certification requirements**
- **Evaluated state-wide Class B inspections**
 - **Compared free chlorine violations from certified operator pools (Douglas County and Lincoln) with those from pools without operator certification requirements (all other counties)**

Control of Source Water pH Variations

- Prevalence of pH violations affected by pH and alkalinity of pool source water
- Limited analyses to inspections from selected cities in Sarpy County and all of Douglas County
 - Shared metropolitan utilities district
 - Common surface-water source
 - Sarpy County
 - Class B operator certification not required
 - Location of outbreak pool



Photo sources: www.westchicago.org (left); www.va.water.usgs.gov (right)

Analysis of pH Violations

- **Evaluated pH violations (pH < 7.2 or pH > 7.8) and concurrent pH and free chlorine violations**
- **Compared Class B pool inspections in Douglas County with those in selected Sarpy County locations**
- **Compared Class B inspections with Class A inspections within selected Sarpy County locations only**

Results

Number of Pools and Routine Inspections — Nebraska, 2005–2006

Class B Operator Certification Requirement	Number of Pools by Class			Number of Routine Inspections by Class		
	A	B	All	A	B	All
Yes	59	367	426	133	876	1,009
No	221	247	468	460	541	1,001
Total	280	614	894	593	1,417	2,010

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214 had 1 inspection; 680 >1 inspection
median: 2; range: 1-7

Free Chlorine Violations — Counties without Class B Operator Certification Requirements

Free chlorine violation

	Yes	No	
Class B	167	374	541
Class A	60	400	460
	227	774	1,001

Free Chlorine Violations — Counties without Class B Operator Certification Requirements

Prevalence Ratio = **2.4** (95% CI, 1.8–3.1)

Free chlorine violation

	Yes	No	
Class B	167	374	541
Class A	60	400	460
	227	774	1,001

Free Chlorine Violations — Class B Pools, All Counties

**Certified
operator
required**

Free chlorine violation

Yes

No

No

167

374

541

Yes

138

738

876

305

1,112

1,417

Free Chlorine Violations — Class B Pools, All Counties

Prevalence Ratio = **2.0** (95% CI, 1.6–2.4)

Certified
operator
required

Free chlorine violation

Yes

No

No

167

374

541

Yes

138

738

876

305

1,112

1,417

pH Violations — Class B Pools, Douglas County and Selected Sarpy County Locations

	pH Violation		
	Yes	No	
Sarpy County	34	92	126
Douglas County	107	473	580
	141	565	706

pH Violations — Class B Pools, Douglas County and Selected Sarpy County Locations

Prevalence Ratio = **1.5** (95% CI, 1.05–2.04)

pH Violation

	Yes	No	
Sarpy County	34	92	126
Douglas County	107	473	580
	141	565	706

Chlorine and pH Violations — Class B, Douglas County and Selected Sarpy County Locations

Both violations

	Yes	No	
Sarpy County	16	110	126
Douglas County	36	544	580
	52	654	706

Chlorine and pH Violations — Class B, Douglas County and Selected Sarpy County Locations

Prevalence Ratio = **2.1** (95% CI, 1.2–3.6)

Both violations

	Yes	No	
Sarpy County	16	110	126
Douglas County	36	544	580
	52	654	706

pH Violations — Selected Sarpy County Locations

	pH Violation		
	Yes	No	
Class B	34	92	126
Class A	2	29	31
	36	121	157

pH Violations — Selected Sarpy County Locations

Prevalence Ratio = **4.2** (95% CI, 1.1–16.5)

	pH Violation		
	Yes	No	
Class B	34	92	126
Class A	2	29	31
	36	121	157

Concurrent Chlorine and pH Violations — Selected Sarpy County Locations

Both violations

	Yes	No	
Class B	16	110	126
Class A	1	30	31
	17	140	157

Concurrent Chlorine and pH Violations — Selected Sarpy County Locations

Prevalence Ratio = **4.0** (95% CI, 0.5–28.6)

Both violations

	Yes	No	
Class B	16	110	126
Class A	1	30	31
	17	140	157

Multivariable Analysis

- Logistic regression demonstrated that crude prevalence ratios (PR) did not change substantially after accounting for frequency of inspection
- Data not shown

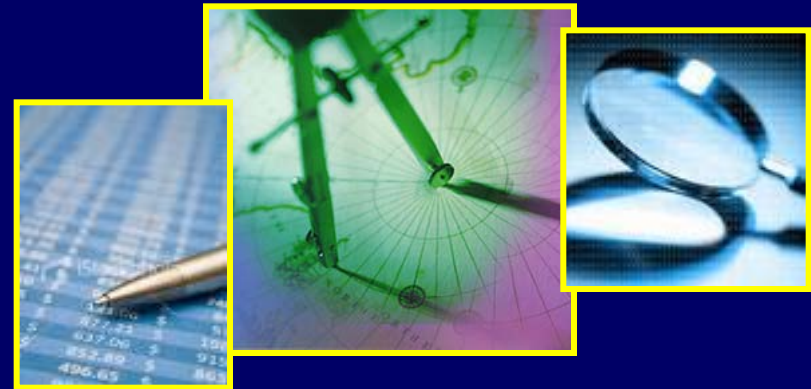


Photo sources: www1.istockphoto.com (left); www.rsvpresearch.com (center); www.theoreminc.net (right)

Discussion

- **Mandatory operator training holds potential to**
 - Improve public swimming pool operation and water quality
 - Enhance swimming safety
- **Routine analysis of pool inspection data**
 - Useful tool for public health decision making
 - Might hold potential for evaluating interventions

Limitations

- **Operator training not directly assessed**
- **Multiple inspectors from 8 agencies**
- **Did not account for**
 - **Pools with non-public water sources or same operators**
 - **Operator experience**
 - **Type of chlorination system**
 - **Pool type (indoor versus outdoor), age, and size**

Conclusions

- **Water chemistry violations are more common in Class B pools in Nebraska counties that do not require certified operators**
- **Trained pool operators play critical role to enhance prevention of recreational water illness (RWI)**

Recommendations

- Swimming pool industry should encourage training for **all** public pool operators
- Public pool operators and staff should pursue training and maintain proficiency
- Nebraska and other states or jurisdictions should consider requiring operator certification for **all** public swimming pools

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References

- CDC. Ocular and Respiratory Illness Associated with an Indoor Swimming Pool—Nebraska, 2006. MMWR Morb Mortal Wkly Rep 2007;56(36):929–932.
- Metropolitan Utilities District, Omaha, NE. Your 2005 water quality report. Available at: <http://www.mudomaha.com/water/05.ccr.pdf>.
- Metropolitan Utilities District, Omaha, NE. Your 2006 water quality report. Available at: <http://www.mudomaha.com/water/06.ccr.pdf>.
- Addy, K, Green, L, Herron E., pH and alkalinity. University of Rhode Island Cooperative Extension, 2004. Available at: <http://www.uri.edu/ce/wq/ww/Publications/pH&alkalinity.pdf>.
- Lincoln Water System, Lincoln, NE. Annual drinking water quality report for 2005. Available at: <http://www.lincoln.ne.gov/city/pworks/water/wtrqual/pdf/water05.pdf>.

References

- U.S. Bureau of the Census. Statistical abstract of the United States: 1995. 115th ed. Washington, DC: US Bureau of the Census, 1995.
- CDC. Surveillance data from swimming pool inspections—selected states and counties, United States, May–September 2002. MMWR 2003;52:513–6.
- Dziuban EJ, Liang JL, Craun GF, Hill V, Yu PA, Painter J, et al. Surveillance for waterborne disease and outbreaks associated with recreational water—United States, 2003-2004. MMWR Surveill Summ. 2006 Dec 22;55(12):1-30.
- Nebraska Health and Human Services, Regulation and Licensure. Operation and management of public swimming pools, 178 NAC 2 (June 8, 2004). Available at: <http://www.hhs.state.ne.us/reg/T178.htm>.
- Lachocki TM. Pool and spa operator training—a smart choice. The Official Newsletter of the NSPF®. 2006;41(4):5,12–14. Available at: http://www.nspf.org/Documents/Newsletters/Vol41_04_2006.pdf.

Calculation of Prevalence Ratio as Measure of Association

$$\text{Prevalence Ratio} = \frac{\text{Prevalence in exposed}}{\text{Prevalence in unexposed}} = \frac{A/A+B}{C/C+D}$$

	Outcome		
	+	-	
Exposed	A	B	A + B
Not exposed	C	D	C + D
	A + C	B + D	Total

Prevalence Ratio (PR)

- PR indicates direction and strength of association
- $PR > 1$ — positive, might be causal
- $PR = 1$ — no association
- $PR < 1$ — negative, might be protective



Photo sources: www.theoreminc.net (left); www.pblunit10.com (right)

Multivariable Analysis

- Pools not inspected with equal frequency
- Logistic regression used to determine if frequency of inspection changed crude prevalence ratios (PR)

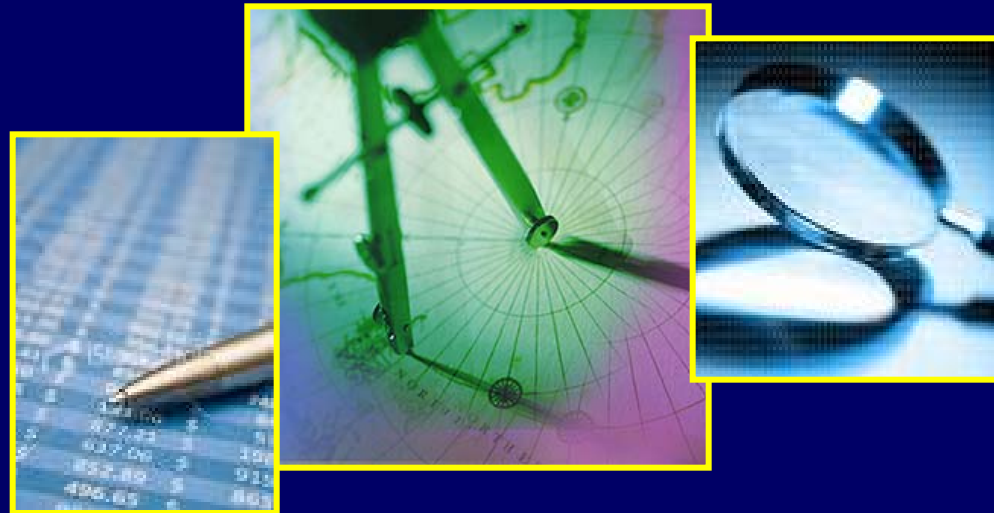


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Evaluation of pH Violations

- **Calculated pH violation frequency for Class B pools state-wide and by county**
 - Class B pH violations were not evenly distributed between locations that require operator certification
- **Compared inspections from Douglas County and Lincoln pools**
 - Assessed association between pH violations and pool source water pH

pH Violations Among Statewide Class B Pool Inspections (n=1,417)

Total pH Violations N (%)	Douglas and Sarpy Counties N (%)	Other 91 Counties N (%)
210 (15)	153 (73)	57 (27)

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2005–2006 Water Quality Reports

	Douglas and Sarpy Counties (Surface Water)
pH	8.8–9.0
Alkalinity	

2005–2006 Water Quality Reports

Douglas and Sarpy Counties (Surface Water)	
pH	8.8–9.0
Alkalinity	83–140 ppm

2005–2006 Water Quality Reports

	Douglas and Sarpy Counties (Surface Water)	City of Lincoln (Groundwater)
pH	8.8–9.0	
Alkalinity	83–140 ppm	

2005–2006 Water Quality Reports

	Douglas and Sarpy Counties (Surface Water)	City of Lincoln (Groundwater)
pH	8.8–9.0	7.6
Alkalinity	83–140 ppm	144 ppm

pH Violations in Douglas County and City of Lincoln Class B Pool Inspections

Total (n=876) N (%)	Douglas County (n=580) N (%)	City of Lincoln (n=226) N (%)
115 (13)	107 (93)	8 (7)

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115 (13)	107 (93)	8 (7)

***Majority of pH violations in Douglas County were low (<7.2), indicating over-correction by operators**

Discussion

- **pH and alkalinity of source water entering pools affects operator's ability to manage pH**
- **Surface water — ↑ pH, ↑ alkalinity**
 - Challenge when pool operators attempt to lower and maintain pH
- **Groundwater — ↑ alkalinity, pH ~ 7.6**
 - High alkalinity helps stabilize pH
 - No or only slight pH adjustment required